

(12) UK Patent Application (19) GB (11) 2 320 513 (13) A

(43) Date of A Publication 24.06.1998

(21) Application No 9726351.1

(22) Date of Filing 12.12.1997

(30) Priority Data

(31) 60033171	(32) 17.12.1996	(33) US
60034366	26.12.1996	
08852983	08.05.1997	

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(51) INT CL⁶

E21B 33/043

(52) UK CL (Edition P)

E1F FJR

(56) Documents Cited

None

(58) Field of Search

UK CL (Edition P) E1F FJB FJC FJR

INT CL⁶ E21B 33/03 33/04 33/043

Online: WPI

(54) A wellhead assembly

(57) A subsea wellhead has an internal tree cap (37) with an isolation sleeve (39) that stabs into a receptacle (41) in the upper end of the tubing hanger (21). The isolation sleeve (39) is sealed in the bore of the tubing hanger (21) by seals (43). To allow displacement of fluid when landing a crown plug (51), or when landing the crown plug internal tree cap together, a vent passage (67) leads through the tubing hanger (21) to a valved passage (76) in the christmas tree (11). In further embodiments the vent passage is replaced by a spring-biased valve in the crown plug (figure 4) or in a combined plug and tree cap (figure 5).

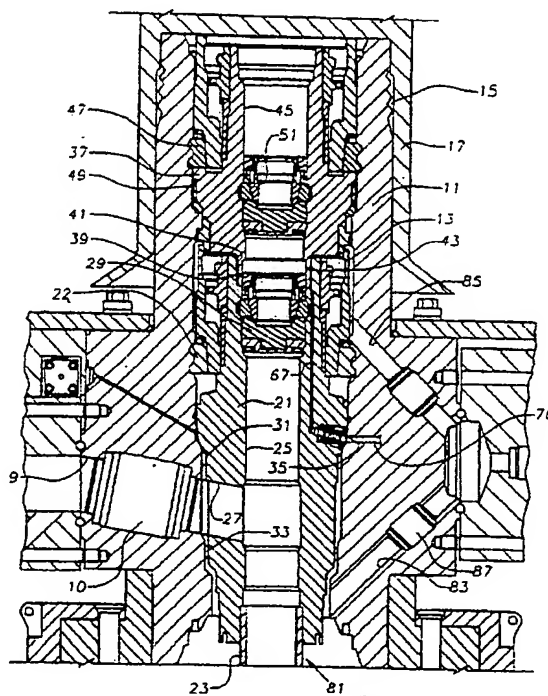


Fig. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

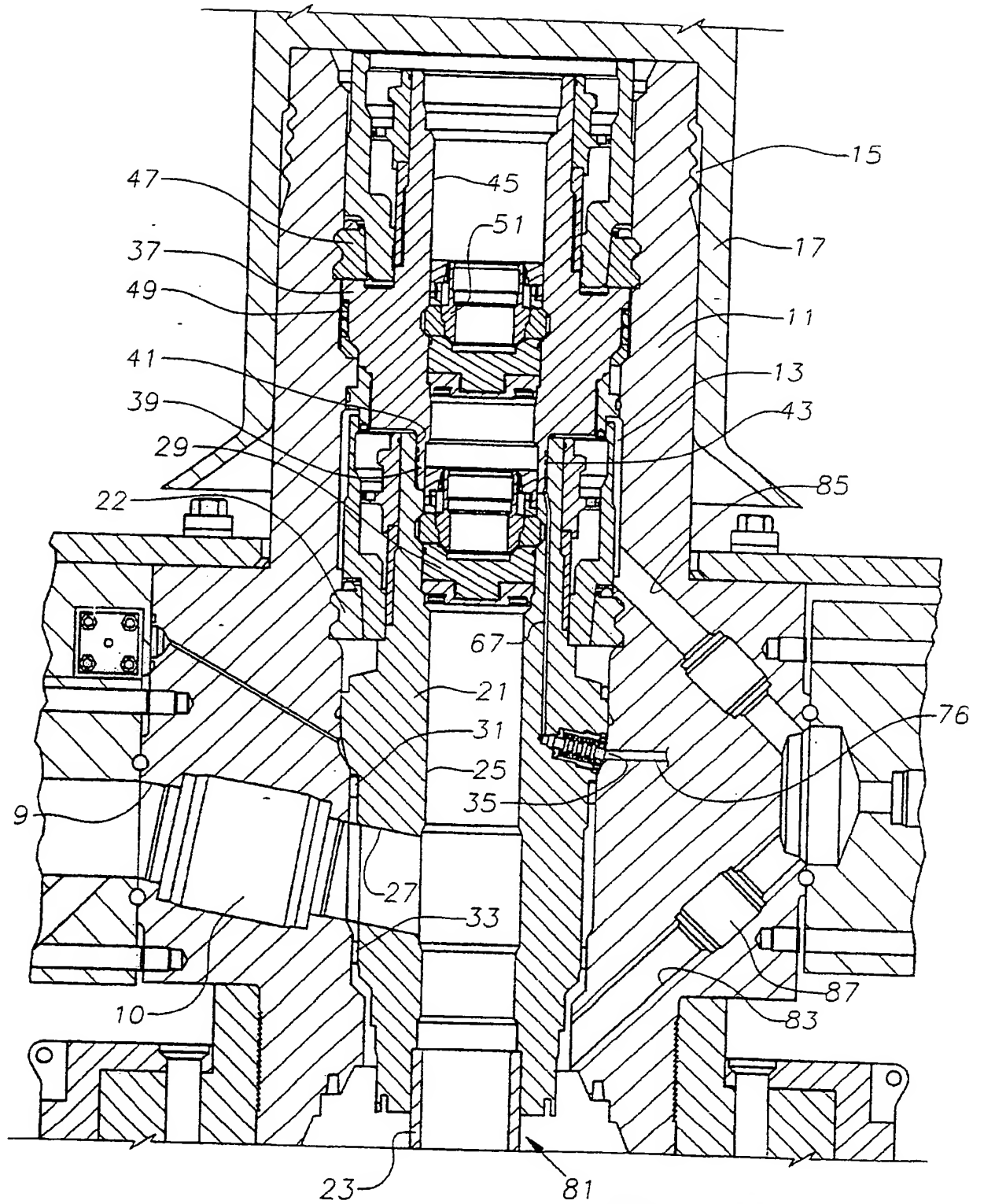


Fig. 1

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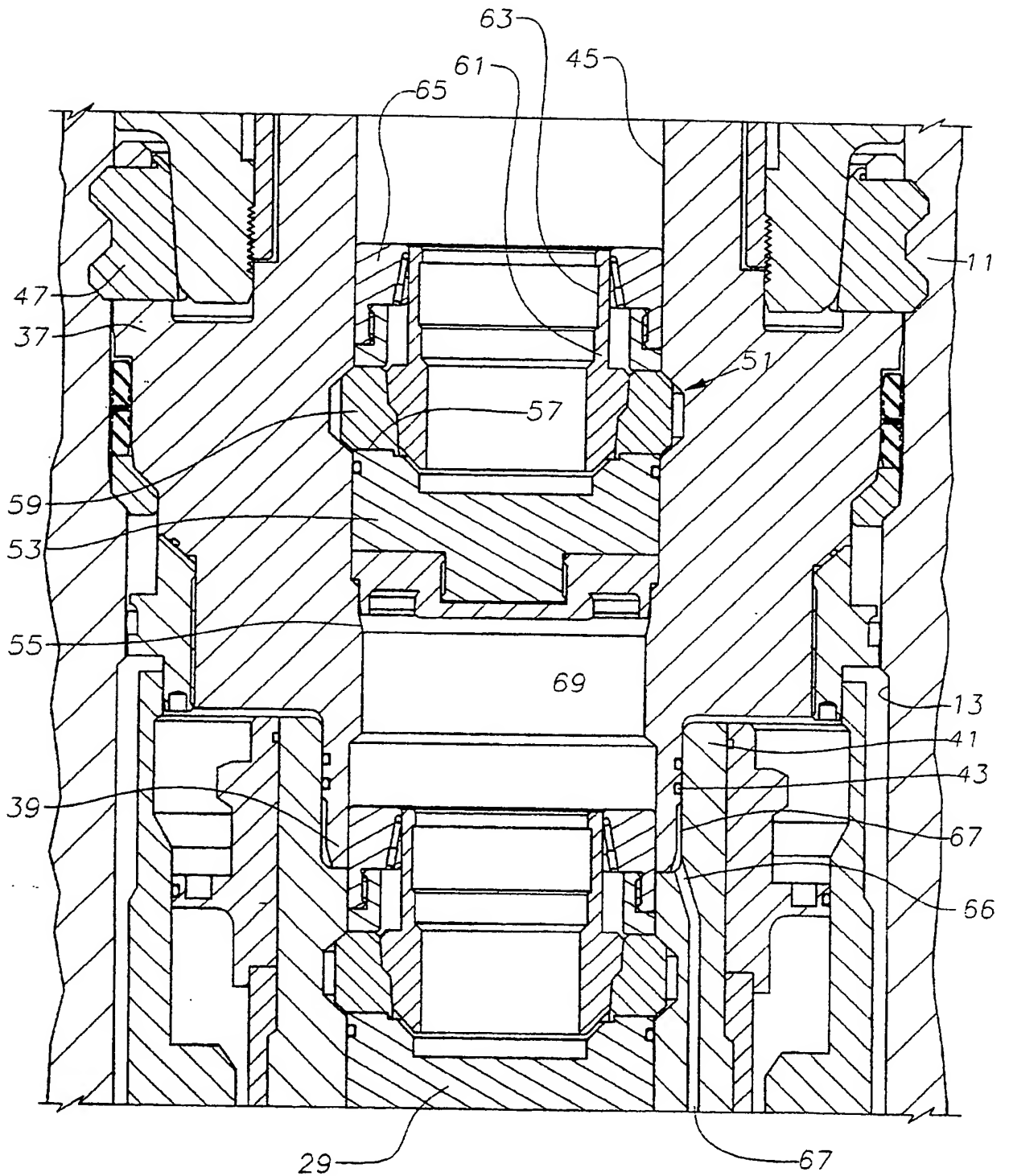
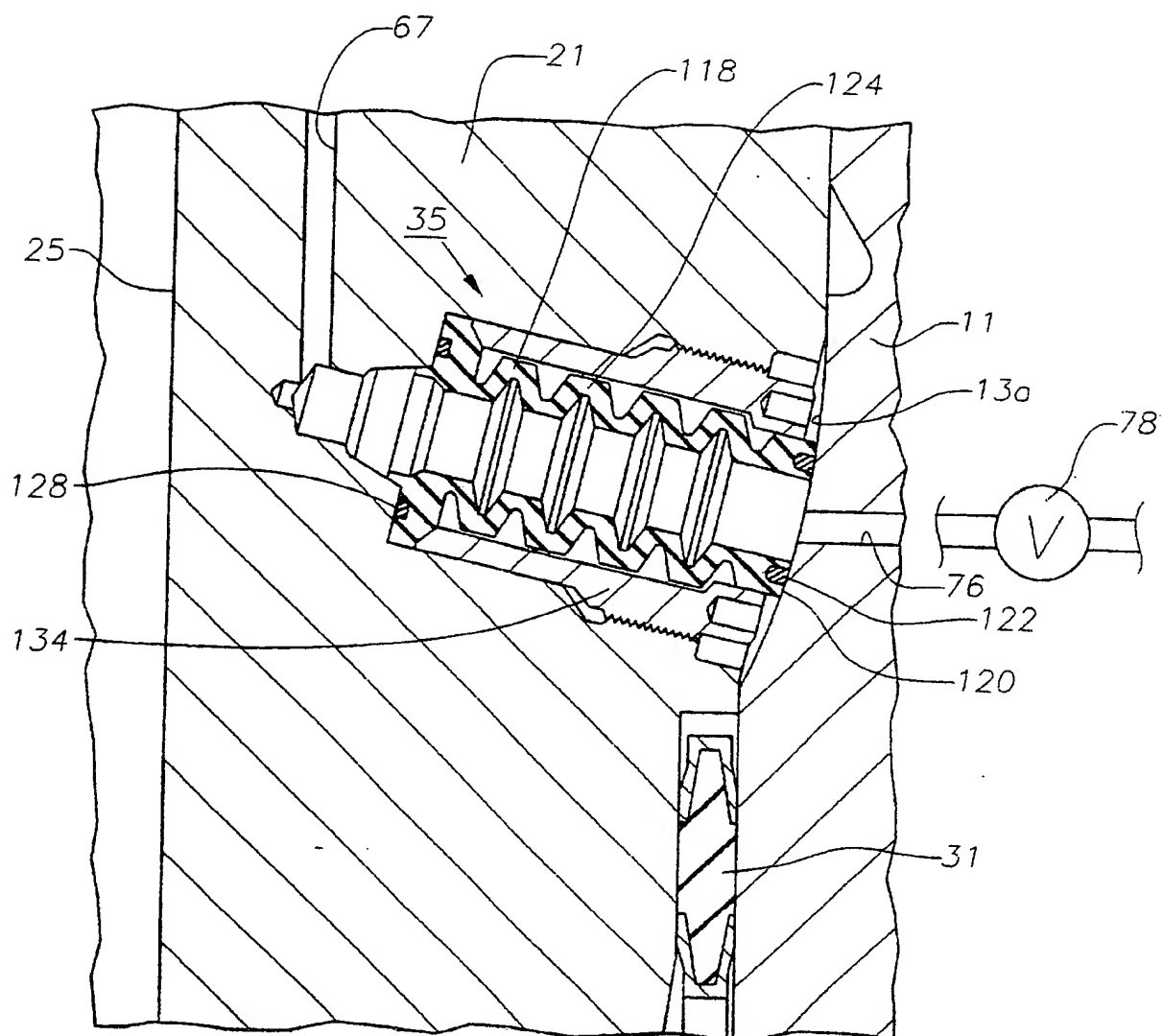


Fig. 2

**Fig. 3**

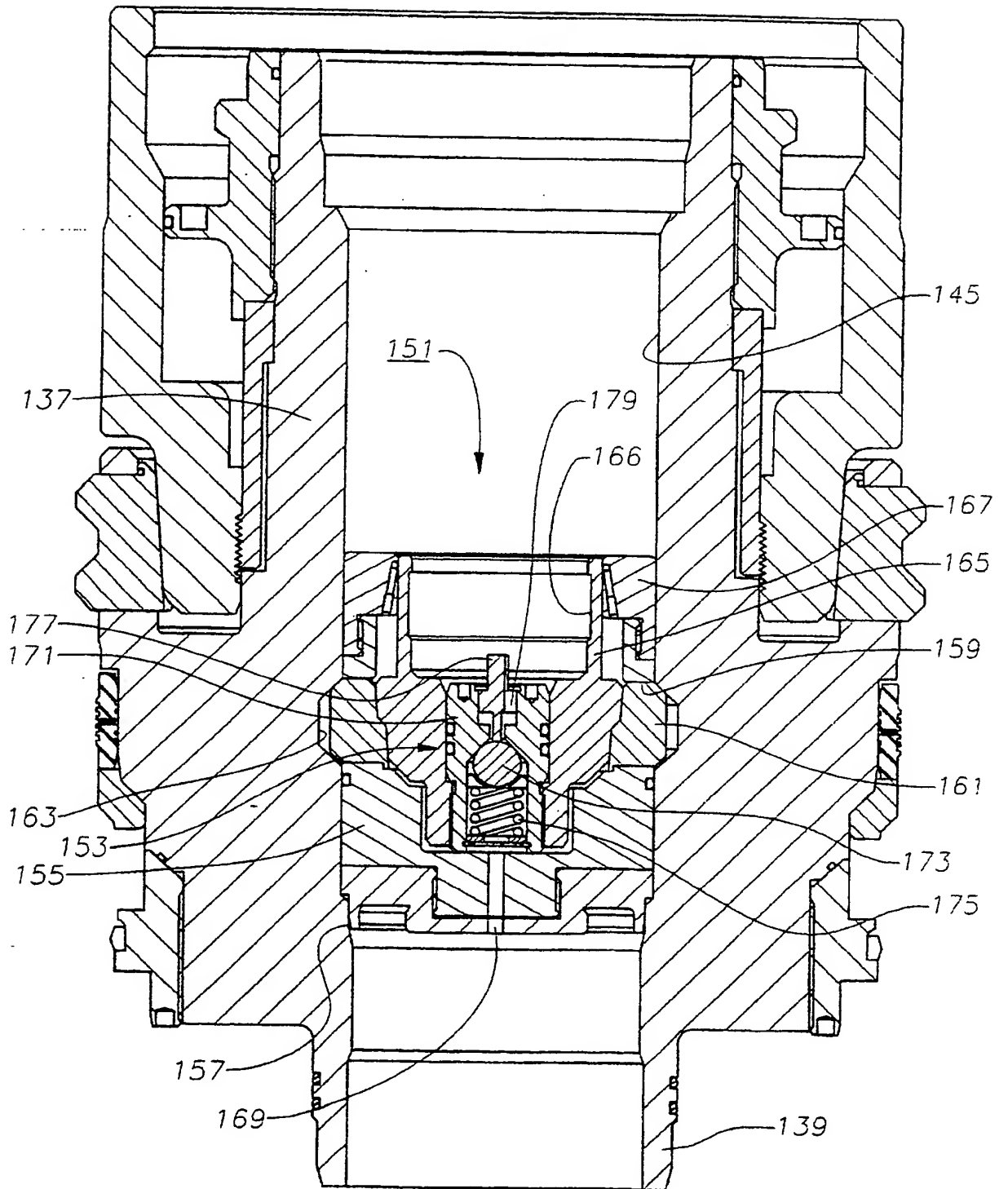


Fig. 4

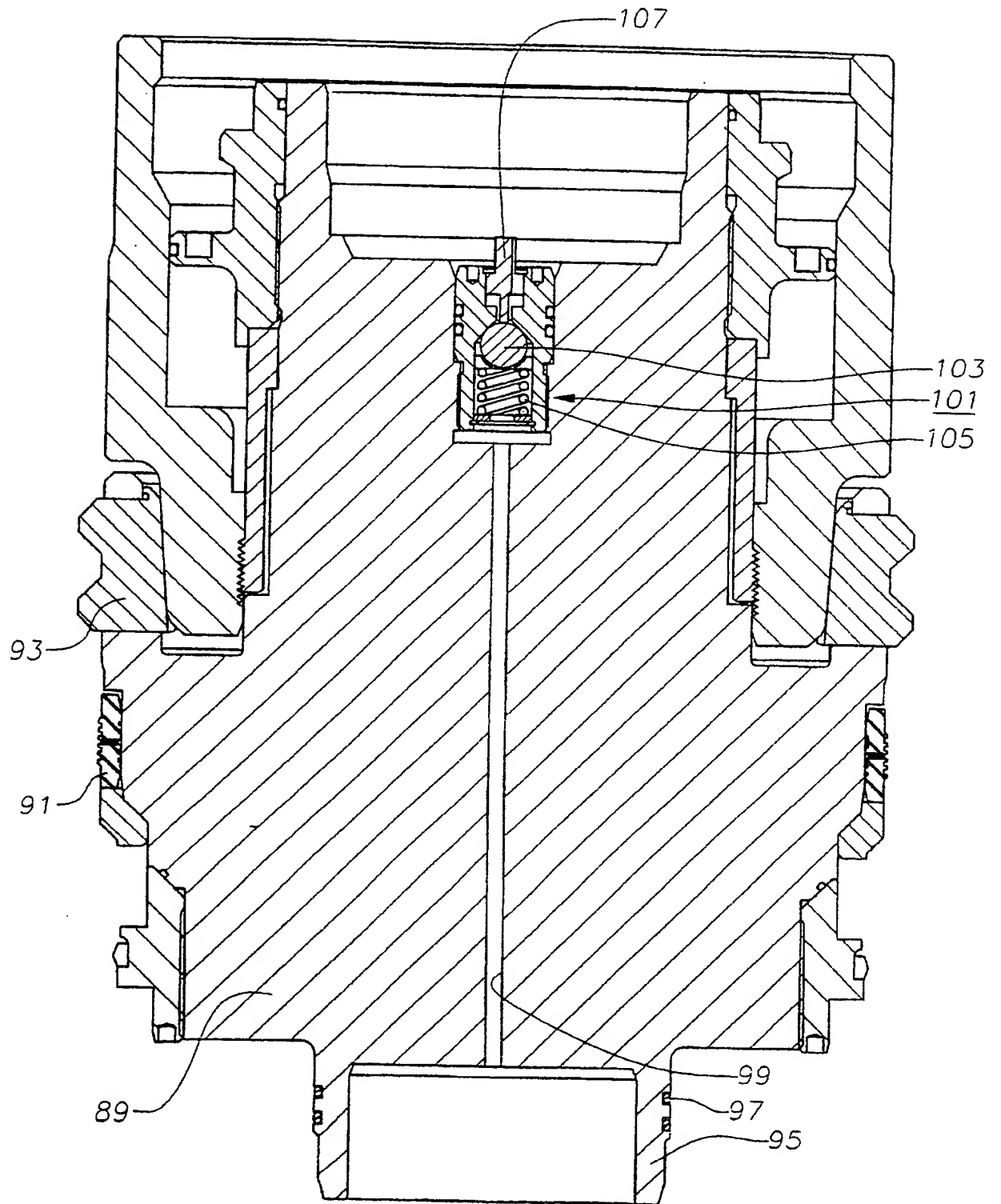


Fig. 5

TUBING HANGER VENT

Inventors: Martin J. Pritchett and Norman Brammer

Technical Field

This invention relates in general to oil and gas well christmas trees, and in particular to a tree cap for a horizontal tree.

Background Art

One type of wellhead assembly, particularly used offshore, is known as a horizontal tree. The well has a wellhead housing which contains casing hangers, each secured to a string of production casing that extends into the well. The tree mounts on top of the wellhead housing. The tree has a vertical bore and a horizontal or lateral production flow outlet. A tubing hanger lands in the bore of the tree and is secured to a string of production tubing extending through the casing hangers and into the well. The tubing hanger has a lateral flow passage that registers with the lateral passage of the horizontal tree.

1 A plug, normally wireline retrievable, fits in the
2 vertical passage of the tubing hanger above the lateral
3 passage. A tree cap fits above the tubing hanger in the
4 bore of the tree. The tree cap may have a vertical
5 passage with a wireline retrievable crown plug or it may
6 be a solid cap. A corrosion cap fits over the upper end
7 of the tree.

8 A tubing annulus between the tubing and the casing
9 communicates to a lower annulus port formed in the tree.
10 This port leads through an annulus passage to an upper
11 annulus port which extends into the bore of the tree
12 above the tubing hanger seals. One or more valves are
13 used to open and close the tubing annulus. The upper
14 tubing annulus port communicates with a void that is
15 located between the tubing hanger wireline plug and the
16 seal of the internal tree cap. In the prior art,
17 removing the crown plug from the internal tree cap will
18 provide a communication between the upper tubing annulus
19 port and the vertical passage in the internal tree cap.

1 Disclosure of Invention

2 The internal tree cap of this invention has an
3 isolation sleeve that stabs into a receptacle in the
4 upper end of the tubing hanger. A seal on the exterior
5 of the isolation sleeve seals an inner void within the
6 isolation sleeve from an outer void. The inner void is
7 the area between the tubing hanger wireline plug and the
8 tree cap. The outer void is an area surrounding the
9 tubing hanger above the tubing hanger upper seal and
10 below the tree cap seal. The internal tree cap may have
11 a bore and an upper crown plug that is wireline
12 retrievable.

13 Fluid will be trapped in the inner void when the
14 isolation sleeve is stabbed into the receptacle above the
15 tubing hanger. To allow displacement of the fluid when
16 landing the upper crown plug, or when landing the upper
17 crown plug and internal tree cap together, a vent passage
18 leads through the tubing hanger to an external valve.
19 This vent passage is preferably controlled by a metal
20 sealing needle valve which is shut by an ROV or diver.

1 Brief Description Drawings

2 Figure 1 is a vertical sectional view of a portion
3 of a horizontal tree constructed in accordance with this
4 invention.

5 Figure 2 is an enlarged view of the internal tree
6 cap of the horizontal tree of Figure 1.

7 Figure 3 is an enlarged view of a seal for the vent
8 passage of the horizontal tree of Figure 1.

9 Figure 4 is an enlarged sectional view of a second
10 embodiment of the invention.

11 Figure 5 is an enlarged sectional view of a third
12 embodiment of the invention.

13
14 Best Mode for Carrying Out the Invention

15 Referring to Figure 1, christmas tree 11 is of a
16 type known as a horizontal tree. It has a vertical or
17 axial tree bore 13 extending completely through it. A
18 set of grooves 15 are located on the exterior near the
19 upper end for connection to a drilling riser. A
20 removable corrosion cover 17 fits over the upper end of
21 tree 11. Tree 11 has a lateral production passage 19
22 that extends generally horizontally from bore 13 and is
23 controlled by a valve 20. Tree 11 will be landed on top

1 of a wellhead housing (not shown) which has casing
2 extending into a well.

3 A tubing hanger 21 lands sealingly in bore 13.
4 Tubing hanger 21 is secured to tree 11 by a lock down
5 mechanism 22. A string of production tubing 23 extends
6 through the casing hangers (not shown) into the well for
7 the flow of production fluid. Production tubing 23
8 communicates with a vertical passage 25 that extends
9 through tubing hanger 21. A lateral passage 27 extends
10 from vertical passage 25 and aligns with tree lateral
11 passage 19.

12 A wireline retrievable plug 29 will lock in vertical
13 passage 25, sealing the upper end of vertical passage 25.
14 Tubing hanger 21 has an upper seal 31 located above
15 lateral passage 27 and a lower seal 33 located below
16 lateral passage 27. Seals 31, 33 seal to bore 13 of tree
17 11. A radial port 35 in tubing hanger 21 communicates
18 with a passage 67 that extends upward through tubing
19 hanger 21.

20 In the preferred embodiment (Figure 3), a seal
21 member 118 seals against a spherical sidewall port 13a of
22 bore 13. Seal member 118 is metal, tubular and located
23 within port 35. Seal member 118 has a metal seal 120 on

1 its face and elastomeric seals 122, 128 located on its
2 outer ends. Seal member 118 also has a tubular sidewall
3 124. A retainer 134 surrounds seal member 118 to hold it
4 in port 35. A passage 76 leads from port 35 through tree
5 11 to an outer valve 78 which controls port 35. Outer
6 valve 78 is a metal sealing needle valve which is
7 operated by an ROV or a diver after installation when
8 retrieval operations are complete.

9 Referring to Figures 1 and 2, a tree cap 37 inserts
10 sealingly into tree bore 13 above tubing hanger 21. Tree
11 cap 37 has a downward depending isolation sleeve 39 that
12 is coaxial. Sleeve 39 fits within a receptacle 41 formed
13 on the upper end of tubing hanger 21. Passage 67
14 communicates with a vent port 66 located at the interface
15 between sleeve 39 and receptacle 41. Seals 43 located on
16 sleeve 39 seal to receptacle 41 above vent port 66. The
17 interior of sleeve 39 communicates with an axial passage
18 45 that extends through tree cap 37. Axial passage 45
19 has approximately the same inner diameter as tubing
20 hanger passage 25. A locking mechanism 47 similar to
21 that of the tubing hanger locking mechanism 22 is used to
22 lock tree cap 37 to tree 11. A seal 49 seals tree cap 37
23 to tree bore 13.

1 An upper wireline retrievable crown plug 51 inserts
2 into tree cap passage 45. Referring to Figure 2, crown
3 plug 51 has a body 53 with a metal seal 55 on its lower
4 end. Metal seal 55 is a depending lip that engages a
5 tapered surface in passage 45. Body 53 has a plurality
6 of windows 57 which allow dogs 59 to extend and retract.
7 Dogs 59 are pushed outward by a central cam member 61.
8 Cam member 61 has a profile 63 on its upper end for
9 engagement by a running tool. Cam member 61 moves
10 between a lower position shown and an upper position
11 freeing dogs 59 to retract. A retainer 65 secures to the
12 upper end of body 53 to retain cam member 61.

13 Referring again to Figure 1, a tubing annulus 81
14 surrounds tubing 23 between tubing 23 and the smallest
15 diameter string of casing (not shown). Tubing annulus 81
16 communicates with a lower annulus passage 83 that extends
17 from tree bore 13 through the wall of tree 11 below
18 tubing hanger seal 33. Lower annulus passage 83
19 communicates with an upper annulus passage 85 that
20 extends into tree bore 13 above tubing hanger seal 31 and
21 below tree cap seal 49. Valves 87 are located in annulus
22 passages 83, 85.

1 In operation, after the well has been drilled and
2 cased, the operator lowers tree 11 onto the wellhead
3 housing (not shown). The operator then may install
4 production tubing 23. Tubing hanger 21 lands in bore 13
5 with its passage 27 aligning with horizontal passage 19.
6 Wireline plug 29 may be installed with a wireline tool.

7 Wireline plug 51 will be installed and tested in
8 tree cap 37 at the rig. Then, tree cap 37 is lowered on
9 a string of conduit, such as drill pipe. Isolation
10 sleeve 39 will stab into receptacle 41 as locking
11 mechanism 47 locks tree cap 37 to bore 13. Excess fluid
12 trapped between plugs 29, 51 may flow out vent passage
13 67, through radial port 35, passage 76 and valve 78.

14 For a workover operation in which tubing 23 needs to
15 be pulled, a drilling riser can be employed. After
16 removal of corrosion cap 17, the operator installs a
17 drilling riser to profile 15, the drilling riser having
18 a blowout preventer (not shown). The operator will lower
19 a drill string into engagement with tree cap 37 and
20 retrieve it. After pulling internal tree cap 37, the
21 operator may circulate a kill fluid to kill the well.

22 To do so, the operator installs an inner riser
23 string (not shown) which stabs into receptacle 41 of

1 tubing hanger 21. Pipe rams (not shown) in the drilling
2 riser are closed around the inner riser string. Upper
3 tubing annulus passage 85 now communicates with an
4 annulus surrounding the inner riser, which in turn
5 communicates with choke and kill lines leading alongside
6 the riser back to the drilling rig. The operator will
7 pull wireline plug 29 with a wireline tool. A port (not
8 shown) at the lower end of tubing 23 will be opened to
9 communicate the interior of tubing 23 with tubing annulus
10 81. This may be done with a wireline tool in a
11 conventional manner. With production valve 20 closed and
12 tubing annulus valve 87 open, the operator can pump down
13 the inner riser, down tubing 23 and back up tubing
14 annulus 81. The annulus fluid circulates through annulus
15 passages 83, 85, up tree bore 13 and through the choke
16 and kill lines to the surface. After the kill fluid has
17 been placed in the well, the operator may pull production
18 tubing 23.

19 Under some circumstances, an operator may wish to
20 achieve wireline intervention into tubing 23 without
21 killing the well and without using the drilling riser.
22 Wireline access is achievable with the well under flowing
23 conditions. A wireline riser (not shown) will be

installed in the upper portion of passage 45 of tree cap
37. The operator can use a wireline tool to engage crown
plug 51. The operator will retrieve plugs 51, 29 in a
conventional manner to perform the wireline intervention.
Plugs 51, 29 may be reinstalled conventionally. Vent
port 67 avoids hydraulic lock when landing plug 51.

Referring to Figure 4, a second embodiment of the
invention is shown. A wireline retrievable crown plug
151 inserts into a tree cap passage 145 in an internal
tree cap 137. Crown plug 151 has a vent check valve 153
that when opened will allow pressure from below to vent
upward above check valve 153. Check valve 153 has a body
155 which has a metal seal 157 secured to its lower end.
Seal 157 is a depending lip that seals against a tapered
surface formed in tree cap passage 145. Body 155 has a
plurality of windows 159 which allows dogs 161 to
protrude through. When in the outer locked position,
dogs 161 will engage a groove 163 in tree cap passage 45.
A cam member 165 is carried reciprocally within body 155.
When in the lower position, cam member 165 keeps dogs 161
in the outer locked position. When cam member 165 is
pulled upward, it will allow dogs 161 to retract from
groove 163. Cam member 165 has a profile 166 on its

1 upper end to allow engagement of a running and retrieval
2 tool (not shown). A retainer 167 secures to the upper
3 end of body 155 to retain cam member 165. A vent port
4 169 extends axially through body 155 to the lower end of
5 cam member 165.

6 Check valve 153 is located within a cavity in cam
7 member 165. Check valve 153 includes a valve body 171
8 carried within an axial cavity in cam member 165. A ball
9 173 is urged upward by a spring 175 against a seat for
10 blocking any flow from below. A plunger 177 extends
11 upward from valve body 171. Plunger 177 can be stroked
12 downward by the running tool, and moves upward in
13 response to the force of spring 175. When stroked
14 downward from the position shown, it pushes ball 173
15 downward, allowing upward flow past the seat. Plunger
16 177 has a flow channel 179 to allow flow of fluid in an
17 upward direction when it is pushed downward.

18 Preferably, crown plug 151 will be installed in tree
19 cap 37 and pressure tested while tree cap 137 is at the
20 drilling rig. Tree cap 137 will be lowered on a running
21 tool on drill pipe. Check valve 153 will be held in an
22 open position while isolation sleeve 139 stabs into a
23 receptacle (not shown). Preferably this is handled by a

1 mechanical device on the lower end of the running tool
2 (not shown). The open position of check valve 153 allows
3 displacement of trapped fluid between wireline plugs 29,
4 151. The fluid flows up vent passage 169 and through
5 check valve 153 into tree cap passage 45 above crown plug
6 151. After installation and testing, the running tool is
7 retrieved, causing check valve 153 to close due to the
8 force of spring 175. Check valve 153 serves as a second
9 pressure barrier to the wireline plug in the tubing
10 hanger.

11 For a workover operation requiring the pulling of
12 tubing 23 (Figure 1), the operator may use a drilling
13 riser and blowout preventer stack (not shown). Normally,
14 a kill fluid will be circulated into the well which is
15 heavier than the well fluid to prevent a blowout. The
16 operator will land a running tool on internal tree cap
17 37, which at the same time depresses plunger 177 to vent
18 any pressure buildup in an inner void 188 between the two
19 wireline plugs 29, 151. This will inform the operator
20 whether or not the tubing hanger wireline plug had been
21 leaking.

22 The operator then pulls internal tree cap 37 and
23 runs back in with an inner riser string (not shown) which

1 stabs into the receptacle of the tubing hanger. Pipe
2 rams (not shown) in the drilling riser are closed around
3 the inner riser string. Upper tubing annulus passage 85
4 (Figure 1) now communicates with an annulus surrounding
5 the inner riser, which in turn communicates with choke
6 and kill lines leading alongside the riser back to the
7 drilling rig. The operator will pull wireline plug 29
8 (Figure 1) with a wireline tool. A port (not shown) at
9 the lower end of tubing 23 will be opened to communicate
10 the interior of tubing 23 with tubing annulus 81. This
11 may be done with a wireline tool in a conventional
12 manner. With production valve 20 (Figure 1) closed and
13 tubing annulus valve 87 open, the operator can pump down
14 the inner riser, down tubing 23 and back up tubing
15 annulus 81. The annulus fluid circulates through annulus
16 passages 83, 85, up tree bore 13 and through the choke
17 and kill lines to the surface. After the kill fluid has
18 been placed in the well, the operator may pull production
19 tubing 23.

20 Under some circumstances, an operator may wish to
21 achieve wireline intervention into tubing 23 without
22 killing the well and without using the drilling riser.
23 Wireline access is achievable with the well under flowing

1 conditions. A wireline riser (not shown) will be
2 installed in the upper portion of passage 145 of tree cap
3 137. The operator can use a wireline tool to engage
4 crown plug 151. Check valve 153 will be opened to vent
5 off any pressure buildup that might exist in inner void
6 188 between tubing hanger wireline plug 29 and crown plug
7 151. The operator will retrieve plugs 151, 29 in a
8 conventional manner to perform the wireline intervention.
9 When reinstalling crown plug 151, check valve 153 will be
10 opened to allow displacement of trapped fluid in inner
11 void 188.

12 A third embodiment is shown in Figure 5. In this
13 embodiment, there is no wireline plug, such as crown plug
14 151 contained within tree cap 137 (Figure 4). Instead,
15 tree cap 89 is a solid plug having no means for allowing
16 wireline intervention. Tree cap 89 has a seal 91 that
17 seals to bore 13. A locking mechanism 93 will lock tree
18 cap 89 to tree 11. Tree cap 89 has an isolation sleeve
19 95 that extends into receptacle 41 of tubing hanger 21.
20 Sleeve 95 has seals 97 for sealing to receptacle 41.

21 A vent passage 99 extends through tree cap 89 along
22 its axis. Vent passage 99 is a small passage, not
23 sufficiently large to accommodate a crown plug such as

1 crown plug 51. A check valve 101 is mounted to the upper
2 end of vent passage 99. Check valve 101 is similar to
3 check valve 153. It has a ball 103 which is urged upward
4 by a spring 105 against a seat. A plunger 107 operated
5 by a running tool will depress ball 103 to allow venting
6 of trapped fluid during installation of tree cap 89.

7 The invention has several advantages. The vent port
8 vents fluid from the inner void when landing the upper
9 crown plug, or when landing the upper crown plug and
10 internal tree cap together. The vent port also admits
11 fluid to the void when retrieving the upper crown plug
12 and/or the internal tree cap, thus preventing a vacuum
13 from being formed. In addition, the vent port detects
14 and/or vents build-up pressure in the region due to a
15 leakage in the lower plug. Finally, the vent port
16 permits a pressure test to be carried out on the seals of
17 the upper crown plug and the stab sub of the internal
18 tree cap. The vent port allows separate pressure
19 monitoring of the tubing annulus from the crown plug.

20 While the invention has been shown in only three of
21 its forms, it should be apparent to those skilled in the
22 art that it is not so limited, but is susceptible to

1 various changes without departing from the scope of the
2 invention.

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1 I claim:

2 1. A wellhead assembly, comprising in combination:

3 a christmas tree having an axial bore and a lateral
4 production passage;

5 a tubing hanger landed in the bore of the tree and
6 having a lateral opening that aligns with the lateral
7 production passage in the tree and an axial bore;

8 a retrievable plug landed in the bore of the tubing
9 hanger above the lateral opening;

10 an internal tree cap assembly landed in the bore of
11 the tree above the tubing hanger, the tree cap assembly
12 having a downward depending isolation sleeve which
13 extends into the bore of the tubing hanger;

14 a seal on the isolation sleeve which seals in the
15 bore of the tubing hanger, creating a void between the
16 plug and the internal tree cap; and

17 a vent passage leading from the void for avoiding
18 fluid lock in the void between the plug and the tree cap
19 assembly when the tree cap assembly is landed in the bore
20 of the tree.

21
22 2. The wellhead assembly of claim 1, further comprising
23 a valve for opening and closing the vent passage.

1 3. The wellhead assembly of claim 1, further comprising
2 a check valve in the vent port which prevents flow from
3 the void when in a closed position and allows flow from
4 the passage when in an open position.

5
6 4. The wellhead assembly of claim 1 wherein the vent
7 passage is in the tree cap assembly.

8
9 5. The wellhead assembly of claim 1 wherein the vent
10 passage extends through the tubing hanger and christmas
11 tree to an exterior.

12
13 6. The wellhead assembly of claim 1, further
14 comprising:

15 an axial bore in the tree cap assembly; and

16 a second retrievable plug landed in the bore of the
17 tree cap assembly.

18
19 7. The wellhead assembly of claim 1, further
20 comprising:

21 an axial bore in the tree cap assembly;

1 a second retrievable plug landed in the bore of the
2 tree cap assembly; and wherein the vent passage is in the
3 second plug and further comprising

4 a check valve in the vent passage in the second
5 plug for allowing trapped fluid to be expelled above the
6 second plug when the check valve is in an open position.

7
8 8. The wellhead assembly of claim 1 wherein the vent
9 passage leads axially through the tree cap assembly; and
10 further comprising

11 a check valve in the vent passage for releasing
12 fluid trapped between the tree cap and the plug when the
13 check valve is in an open position.

14
15 9. In a wellhead assembly having a christmas tree with
16 an axial bore, a lateral production passage, and a tubing
17 hanger landed in the bore of the tree, the tubing hanger
18 having an axial bore and a lateral opening that aligns
19 with the lateral production passage in the tree, the
20 improvement comprising:

21 a first retrievable plug landed in the bore of the
22 tubing hanger above the lateral opening;

1 an internal tree cap assembly landed in the bore of
2 the tree above the tubing hanger, the tree cap assembly
3 having an axial bore and a downward depending isolation
4 sleeve which extends into the bore of the tubing hanger;

5 a seal on the isolation sleeve which seals in the
6 bore of the tubing hanger, creating a void between the
7 first plug and the internal tree cap;

8 a second retrievable plug landed in the bore of the
9 tree cap assembly;

10 a vent passage communicating with the void for
11 expelling fluid trapped between the plugs when the tree
12 cap assembly is landed in the bore of the tree; and

13 a valve for opening and closing the vent passage.
14

15 10. The wellhead assembly of claim 9 wherein the vent
16 passage is in the second plug and wherein the valve is a
17 check valve that allows fluid to be expelled from the
18 void when moved to an open position.

19
20 11. The wellhead assembly of claim 9 wherein the vent
21 passage extends through the tree cap assembly.
22

1 12. The wellhead assembly of claim 9 wherein the vent
2 passage extends through the tubing hanger and the tree to
3 an exterior.

4
5 13. The wellhead assembly of claim 9 wherein the vent
6 passage leads axially through the tree cap assembly and
7 the valve is a check valve that allows fluid to be
8 expelled from the void when moved to an open position.

9
10 14. A wellhead assembly, comprising in combination:
11 a christmas tree having an axial bore and a lateral
12 production passage;

13 a tubing hanger landed in the bore of the tree and
14 having a lateral opening that aligns with the lateral
15 production passage in the tree and an axial bore;

16 a first retrievable plug landed in the bore of the
17 tubing hanger above the lateral opening;

18 an internal tree cap landed in the bore of the tree
19 above the tubing hanger, the tree cap having a downward
20 depending isolation sleeve which extends sealingly into
21 the bore of the tubing hanger creating a void between the
22 tree cap and the first plug;

1 a check valve in the tree cap in communication with
2 the void and adapted to be held in an open position when
3 the tree cap is landed in the bore of the tree so that
4 fluid may be released from the void to avoid fluid lock.

5
6 15. The wellhead assembly of claim 14 wherein the tree
7 cap has a bore; and further comprising

8 a second retrievable plug located in the bore of the
9 tree cap; and wherein

10 the check valve is located within the second plug.

11
12 16. The wellhead assembly of claim 14 wherein the tree
13 cap is solid and has an axial passage; and wherein

14 the check valve is located in the axial passage of
15 the tree cap, the axial passage communicating with the
16 check valve and the void.

17
18 17. The wellhead assembly of claim 14 wherein the check
19 valve further comprises:

20 a valve body having a flow channel and a seat;

21 a spring;

22 a ball which is urged upward by the spring against
23 the seat for blocking fluid from the void;

1 a plunger which moves upward in response to the
2 spring; and

3 means for urging the plunger downward so that fluid
4 may be released through the flow channel from the void
5 when the tree cap is landed in the bore of the tree.
6

7 18. In a wellhead assembly having a christmas tree with
8 an axial bore, a lateral production passage, and a tubing
9 hanger landed in the bore of the tree, the tubing hanger
10 having an axial bore and a lateral opening that aligns
11 with the lateral production passage in the tree, the
12 improvement comprising:

13 a first retrievable plug landed in the bore of the
14 tubing hanger above the lateral opening;

15 an internal tree cap assembly landed in the bore of
16 the tree above the tubing hanger, the tree cap assembly
17 having an axial bore and a downward depending isolation
18 sleeve which extends into the bore of the tubing hanger;

19 a seal on the isolation sleeve which seals in the
20 bore of the tubing hanger, creating a void between the
21 first plug and the internal tree cap;

22 a second retrievable plug landed in the bore of the
23 tree cap assembly;

1 a vent passage leading through the tubing hanger
2 between the isolation sleeve and the tubing hanger to an
3 exterior of the tree for expelling fluid trapped between
4 the plugs when the tree cap assembly is landed in the
5 bore of the tree; and

6 a valve for opening and closing the vent passage.
7

8 19. A method for avoiding fluid lock in a wellhead
9 assembly, comprising:

10 (a) providing a christmas tree having an axial bore
11 and a lateral production passage;

12 (b) landing a tubing hanger in the bore of the
13 tree, the tubing hanger having a lateral opening that
14 aligns with the lateral production passage in the tree
15 and an axial bore;

16 (c) landing a retrievable plug in the bore of the
17 tubing hanger above the lateral opening;

18 (d) landing an internal tree cap assembly in the
19 bore of the tree above the tubing hanger, the tree cap
20 assembly having a downward depending isolation sleeve
21 which extends into the bore of the tubing hanger;

1 (e) sealing the isolation sleeve with a seal in the
2 bore of the tubing hanger, creating a void between the
3 plug and the internal tree cap; and then

4 (f) releasing fluid trapped in the void through a
5 vent port for avoiding fluid lock in the void between the
6 plug and the tree cap assembly when the tree cap assembly
7 is landed in the bore of the tree.

8
9 20. The method of claim 19 wherein step (f) comprises
10 releasing fluid through the vent port to an exterior of
11 the tree.

12
13 21. The method of claim 19 wherein step (f) comprises
14 releasing fluid through the vent port and into a vent
15 passage in the tree cap assembly.

16
17 22. The method of claim 19 wherein step (f) comprises
18 releasing fluid through the vent port and into a vent
19 passage in the tubing hanger.

20
21 23. A method for avoiding fluid lock in a wellhead
22 assembly, comprising:

1 (a) providing a christmas tree having an axial bore
2 and a lateral production passage;

3 (b) landing a tubing hanger in the bore of the
4 tree, the tubing hanger having a lateral opening that
5 aligns with the lateral production passage in the tree
6 and an axial bore;

7 (c) landing a first retrievable plug in the bore of
8 the tubing hanger above the lateral opening;

9 (d) landing an internal tree cap assembly in the
10 bore of the tree above the tubing hanger, the tree cap
11 assembly having a downward depending isolation sleeve
12 which extends into the bore of the tubing hanger;

13 (e) landing a second retrievable plug in the bore
14 of the tree cap assembly;

15 (f) sealing the isolation sleeve with a seal in the
16 bore of the tubing hanger, creating a void between the
17 plugs; and then

18 (g) releasing fluid trapped in the void through a
19 vent port for avoiding fluid lock in the void between the
20 plugs when the tree cap assembly is landed in the bore of
21 the tree.

1 24. The method of claim 23 wherein step (g) comprises
2 releasing fluid through the vent port and into a vent
3 passage having a valve.

4
5 25. The method of claim 23 wherein step (g) comprises
6 releasing fluid through the vent port and into a vent
7 passage in the tree cap assembly.

8
9 26. The method of claim 23 wherein step (g) comprises
10 releasing fluid through the vent port and into a vent
11 passage in the tubing hanger.

12
13 27. A method for avoiding fluid lock in a wellhead
14 assembly, comprising:

15 (a) providing a christmas tree having an axial bore
16 and a lateral production passage;

17 (b) landing a tubing hanger in the bore of the
18 tree, the tubing hanger having a lateral opening that
19 aligns with the lateral production passage in the tree
20 and an axial bore;

21 (c) landing a retrievable plug in the bore of the
22 tubing hanger above the lateral opening;

1 (d) landing an internal tree cap assembly in the
2 bore of the tree above the tubing hanger, the tree cap
3 assembly having a downward depending isolation sleeve
4 which extends into the bore of the tubing hanger;

5 (e) sealing the isolation sleeve with a seal in the
6 bore of the tubing hanger, creating a void between the
7 plug and the internal tree cap; and

8 (f) providing a check valve in the tree cap
9 assembly for avoiding fluid lock in the void between the
10 plug and the tree cap assembly when the tree cap assembly
11 is landed in the bore of the tree; and then

12 (g) opening the check valve so that fluid may be
13 released from the void.
14



Application No: GB 9726351.1
Claims searched: 1-27

Examiner: Robert Fender
Date of search: 17 April 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): E1F: FJB, FJC, FJR

Int Cl (Ed.6): E21B: 33/03, 33/04, 33/043

Other: Online WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	NONE	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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